IH 101500
Heat Stress Measurements
(Area Monitoring & Personal Dosimetry)

1.0 Purpose/Scope

This procedure provides a standardized method for the operation of the *QUESTemp 34* Area Heat Stress Monitors and the *QUESTemp II* Personal Heat Stress Monitors. This procedure includes mechanisms for disseminating results to the BNL population by the SHSD Heat Stress Notification system.

The *QUESTemp 34* is used as an area monitor of the site to measure the screening criteria for the workplace heat stress. The site level monitoring determines risk to outdoor workers in typical work clothing (long pants and short-sleeved shirt of cotton or cotton blend).

The site wide area monitoring data is not representative of:
- Work in artificially elevated heat situations such as near ovens and other large heat sources.
- Indoor work.

Conduct area monitoring for workers near heat sources using a *QUESTemp 34* placed in the local environment of these workers.

The site wide area monitoring data is not representative of work while wearing moisture resistant protective clothing such as Tyvek or “PCs”. Conduct personal dosimetry via *QUESTemp II* or physiological body measurements. The QUESTemp° II monitor tracks an individual’s body temperature for indications of the onset of heat stress. It warns the user when their personal body temperature has risen above the "safe" level and that action should be taken to allow the body to cool.

2.0 Responsibilities

2.1 Personnel that perform exposure monitoring with this instrument are responsible to follow all steps in this procedure.

2.2 The data collected using this meter must have an appropriate evaluation of the hazard and risk by a cognizant Industrial Hygiene professional.

3.0 Definitions

Acclimated Worker: physiological adoptions that improve performance in heat that occurs typically after 3 weeks of continued physical activity under heat stress conditions similar to those in the anticipated work. Acclimatization begins to be lost after 4 days of discontinued work.

Heat Stress: is the net heat load to which a worker may be exposed from the combined contributions of metabolic, cost of work, environmental factors (i.e. air temperature, humidity, air movement and radiant heat exchange) and clothing requirements.

Occupational Exposure Limit (OEL): Heat stress is typically regulated in the workplace with regard to either the WBGT index (Wet Bulb Globe Temperature) or the individual's body indicators (core temperature & heart rate). BNL uses the ACGIH screening criteria for heat stress exposure to determine work/rest regimens under normal operations and core body temperature or heart rate when water-vapor-impermeable, air-impermeable or thermally insulating work clothes are worn.

Wet Bulb Globe Temperature (WBGT): a measurement of ambient heat that factors in the influence of wind speed and relative humidity to estimate the risk to workers from heat stress illnesses. Used as screening criteria regulating the work/rest regimen for various levels of the index. This is based on the air temperature, radiant heat, and humidity.

4.0 Prerequisites

Obtaining BNL Web Passwords to access computer for site notification portion of this procedure.

5.0 Precautions

Hazard Determination:

The operation of this meter does not cause exposure to any chemical, physical, or radiological hazards. The meter design does not cause significant ergonomic concerns in routine use. The meter does not generate Hazardous Waste or environmental impact.

Personal Protective Equipment: No PPE is needed to operate this equipment.

Dosimeter Calibration: Failure to calibrate the *QUESTemp II* prior to use may result in an increased margin of error in the results.

6.0 Procedure

Site monitoring:

6.1 Check the weather in the morning during seasons when the temperature is expected to reach 81° F or higher. If the forecast is for temperatures more than 81° F, set up the area heat stress monitor (*QUESTemp 34*).

6.2 Prepare the *QUESTemp 34* meter for outdoor monitoring by placing the sensor head, which is attached to a tri-pod, and setting it up outside. The meter should be placed approximately 10-15' in from the street and aligned with the building and the green 'Building 120' sign on the south side of the building. Extend and secure the tripod legs and the anchors.

6.3 Run the data cable out of the lab room's window to the meter. Make a loose loop with the cable around the center pole under the meter head, so it isn't easily pulled out by movement of the cable. Plug the cable into the base of the unit.

6.4 Fill the water reservoir with distilled water, which is in the bottle hanging on the center pole.

6.5 Run the caution flags from the unit to the building, so no one trips or runs over the wire.

6.6 Operate the *QUESTemp 34* Meter per Attachment 9.2.
6.7 Operate the BNL Heat Stress Site Notification system per Attachment 9.3.
6.8 The heat stress data is automatically stored and can be retrieved by running a report by date, no printing of the daily log is necessary.

Local conditions monitoring:

6.9 If work is done in a setting not covered by the centralized outdoor monitoring site at Building 120 (such as work within buildings or outdoor in areas not accessible to natural breezes), use a *QUESTemp* 34 as a local measuring device in that area.

Personnel dosimetry:

6.10 If outdoor work is done on site in encapsulated suits that prevent the site monitoring from representing the heat stress condition, use the *QUESTemp II* Dosimeter to monitor the workers. Operate the dosimeter as per Attachment 9.4

7.0 Implementation & Training

The monitoring employee's supervision determines their qualification based on the JPM in Attachment 9.5, or an equivalent. Personnel shall re-qualify on at least a three year basis.

8.0 References

- *QUESTemp 34 and QUESTemp II* Operator's Manuals.
- BNL Subject Area Natural Hazards in the Environment
- ACGIH American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, 2005.

9.0 Attachments

9.1 *QUESTemp 34* Area Heat Stress Monitor- Operator Aid
9.2 Site Heat Stress Notification System- Operator Aid
9.3 *QUESTemp II* Personal Heat Stress Dosimeter- Operator Aid
9.4 Job Qualification form

10.0 Documentation

ISM Review - Hazard Categorization	☐ High	☒ Moderate	☐ Low/Skill of the craft
Validation:	☐ Formal Walkthrough	☐ Desk Top Review	☒ SME Review

Rev	Revision History
0	New Procedure. Prepared By: E. Lacina 07/30/04; Reviewed By: J. Peters 7/30/04; Approved By: R. Selvey SHSD IH Group Manager 09/08/04
1	Changed resulting from: SHSD JRA-15 discussion on hazard controls. Minor changes to Section 4 and 7 to reflect current qualification process. Text changes to 6.4 to indicate the worker should insert the plug into the ear not the sampling SME. Revised the format of Section 10 to the most recent format. Reviewer: **R. Selvey 07/07/06**
2	Added document control to the Attachment 9.6. Reviewer: **R. Selvey 05/17/07**
3	Minor text changes in Section 1,2,6 for brevity. Reviewer: **R. Selvey 11/02/10**
4	Merger of IH101450 and addition of *QUESTemp 34* meter. SME Reviewer: R. Selvey 10/01/09
5	Merger of IH101600 Dosimetry into a single SOP. Changes to computer log in for Oracle database. SME Reviewer: R.

	Selvey 08/17/12
6	Revised format of Section 10. Reviewer: R. Selvey 03/05/14
7	Changed QUESTemp 34 to heat stress monitoring and QUESTemp 15 to area monitoring in Section 1.0 Updated Procedure directions in 6.0. Updated Attachment 9.3 Updated Attachment 9.3 Reviewer: S. Retenski 06/25/14 Reviewed by R. Selvey 06/25/14.
8	Total review of procedure. Removed *QUESTemp15 from procedure, Attachments, and operator aid. Reordered attachments.* Reviewed by N. Bernholc 07/22/15.

Attachment 9.1
QUESTemp 34 – Operator Aid

Equipment:

- Meter Body
- Battery (9 volt alkaline)
- Temperature Sensing Head
- Bottle with Distilled or De-ionized Water

1. Electronic warm-up is not required for this meter.
2. The sensor head should be placed in the environment for 10 minutes before logging data so that the thermometers can equilibrate with that area.
3. Place the sensor head 3.5' from ground on a tripod in a location that will not be in the shade for the entire sampling period and is not sheltered from the prevailing winds.
4. Connect the meter sensor head to the meter body via the appropriate data cable or directly into the top of the meter.
5. Add distilled or de-ionized water to the wick of the wet bulb thermometer before use. Check it at least every two hours and add when no pooled liquid is visible.
6. Turning the meter on: Press the <I/O Enter> key on the meter.
7. Clear the memory by pressing the arrow button until you get to <Reset>, press the <I/O Enter> key, and then press and hold the <I/O Enter> key for the 3-2-1 count down.
8. Arrow back to <View>, press the <I/O Enter> key.
9. Press the <Run/Stop> key, (you will see a <*> in the bottom right corner. Data now logs automatically.
10. Recording readings: Use the BNL Heat Stress Record Instrument Form (or logger printout) to record readings.
11. If data logging was used, connect meter to a printer via the data port on the left side.
12. Activate printing by selecting "Print" from the menu, then pressing <I/O Enter> to enter the print mode. Begin printing by pressing the <I/O Enter> key.

Attachment 9.2
BNL Heat Stress Notification Web Page – Operator Aid

1. Connect *QUESTemp 34* meter to computer via the data cable.
2. Start up the computer in the IH Lab and log on with your BNL account. Use the password assigned to your account.
3. Open the BNL home page. To view the internal heat stress page click on the Heat Stress tab or go to: http//ias.bnl.gov/hsm
4. Turn the *QUESTemp 34* on by pressing the <I/O Enter> button.
5. Arrow to <Reset>, press <I/O Enter> key, then press and hold <I/O Enter> for the 3-2-1 countdown to clear past data.
6. Arrow back to <View>, press <I/O Enter> key. (You should now see: Wet . . . C, Dry . . . C)
7. Press the <Run/Stop> key and a <*> be in the bottom right corner (this indicates the unit is connected and recording data.
8. To stop logging data press the "Run/Stop" key and the <*> will disappear.
9. Press and hold the <I/O Enter> key for the 3-2-1 countdown.
10. Arrow to <Reset>, press the <I/O Enter> key, then press and hold <I/O Enter> for the 3-2-1 countdown to clear current data for the next day's monitoring.. (The report is automatically logged, so no daily printing is required.)
11. Arrow back to <View>, press and hold the <I/O Enter> key for the 3-2-1 countdown to turn off the *QUESTemp 34*.
12. Periodically check the meter sensors to ensure the wet bulb is filled with distilled water.

Attachment 9.3
QUESTemp II Dosimeter Operator Aid

Equipment:
Meter Body with cable leading to a small ear mold.
Disposable E.A.R® foam earplug.
Replacement ear loops.
Oral temperature probe w/ disposable sheaths.
RS-232 Serial Computer/Printer Interface
9V Disposable Battery (60 Hrs. runtime)

Start the QUESTemp° II: Turn the meter on by pressing: ON/OFF.
The internal programming version number is displayed (1.7) until a key is depressed. If the battery is low "LO" appears on the screen.

Clear Data from the Memory: To clear the memory and calibration data, the instrument must be in the ***On*** mode.
Press RESET shows 0:03 in the display.
Press and hold the RESET **key** for three seconds as the display counts down from "0:03" to "0:01"then will go blank.
Release the RESET button will display "rES" The unit is then reset to the factory defaults.

Setting up and placing the temperature probe in the worker's ear canal:

- With clean hands, have the worker roll the disposable yellow E.A.R. foam ear plug (containing a black protruding tube) back and forth with the fingers until it forms a small crease-free cylinder.
- Using only light pressure to keep the E.A.R. plug rolled tight, gently slide the plug over the temperature sensor of the earmold assembly. The black tube should slide into the earmold leaving only the yellow foam plug visible. The sensor should fill the black tube of the E.A.R. plug with the tip lying flush with, or just inside of, the outer end of the tube.
- With the E.A.R. plug still rolled tight, have the worker hold on to the blue earmold and quickly insert the rolled up plug into the ear canal and hold it in place until it expands. [Discontinue inserting the plug if pain occurs.] The yellow portion of the earplug should be completely contained within the ear canal without any danger of hurting the inner ear. Fitting is easier if the outer ear is pulled outward and upwards during insertion. If the initial fit is inadequate, remove the plug and repeat the process.
- Allow 6 – 10 minutes for it to stabilize to the correct temperature.

Taking the oral temperature: Collect and record the oral core temperature of the worker utilizing either:

- The QuestempII Oral temperature probe (if provided) with disposable hygiene sheaths. (Attach to

the “Cal” connector on the front of the meter.

- An external oral thermometer.

When taking an oral temperature, the person should be rested and should not have had anything to eat or drink in the past 15 minutes. The probe should be kept under the tongue with the mouth closed. Record the temperature in degrees Celcius.

Entering the workers oral temperature into the meter: This procedure utilizes the oral thermometer reading from Step 6.5.

Pressing CAL once will display '0---'.

Pressing CAL a second time will blink '36.0' representing the core temperature. Adjust this value between 36.0 and 39.0 by pressing the (ARROW) ⇒ key until it displays the core temperature collected from the Oral temperature probe.

Then press ENTER to complete the calibration sequence. 'CAL' will momentarily appear in the display to indicate the CORE temperature minus the EAR temperature value was obtained and is added as an offset to the EAR temperature.

Set the alarm level: The alarm sounds automatically when the set point is reached. A secondary alarm is set as 0.5°C above the alarm set point. The alarm level should be adjusted based on the oral temperature using the formula:

(Oral Temperature °C + 2° C)

but should not be set to exceed: **38°C** for <u>non-acclimated</u> workers and
39°C for <u>acclimated</u> workers.

Example: A worker’s oral temperature is 36.4C. 36.4C + 2C = 38.4C. Set the alarm for 38.0C for an unacclimitized worker and 38.4C for an acclimated worker.

The alarm level may be changed only if the memory is clear, prior to logging data. Once run time has accumulated, the unit must be reset to change the alarm level setting. To view/change the alarm level:

Press ALARM LEVEL to display the current alarm level setting.

Press ALARM LEVEL and (ARROW) ⇒ simultaneously and hold for three seconds. The displayed level will flash and can be altered between 38°C and 39°C using the (ARROW) ⇒ key.

Set the alarm level using the (ARROW) ⇒ key.

Press ENTER when you have reached the appropriate alarm level.

Advise workers of the alarms. Inform them they must exit the area if the alarm sounds. The AUDIBLE ALARM sounds in the speaker located in the ear assembly under three conditions:

When the 10-second-average temperature in the ear canal exceeds the set alarm level (two pulses every second).

When the 10-second-average temperature in the ear canal exceeds O.5 °C above the set alarm level (four pulses every second).

When the battery voltage falls below 7.2 volts, continuous warning. The unit has stopped reading temperature data. Replace the battery immediately.

Start Logging: When work is ready to begin, Press RUN to begin operating and collecting data. Clip the meter to belt or place in a coat, suit, or pant's pocket.

Ending Logging: When monitoring is completed, turn off the unit by holding the ON/OFF key for three seconds. Data will be saved in the unit.

Recording separate events: You can separate the logging into "events" (such as before and after breaks for lunch) by turning the unit off. Shut down the unit by pressing and holding the ON/OFF key for three seconds. This will shut down the instrument for events such as leaving for lunch. Turn the unit on by pressing ON/OFF key, then press RUN again to begin a new event upon return to work.

Discard the yellow ear plug:

- Between workers
- At the end of the day or
- If the plug becomes soiled.

Documenting Sampling Data and Work Conditions readings:
Recorded data may be printed directly to a serial printer or downloaded to a computer.
Provide a copy of the printed data, to the SHSD IH Laboratory Record Custodian.
Notify the monitored employee of results.

Results interpretation:
Data reports are to be reviewed by the cognizant IH professional to determine adequacy of controls, actions taken and corrective actions as needed.
Ensure that a copy of the hazard evaluation report is sent to the IH Laboratory and is included in the ESHQ Directorate Recordkeeping system.
Ensure that a copy of the written hazard evaluation report is sent to the Occupational Medicine Clinic with the worker's BNL Life Number noted.

Printing or Downloading Stored Data

Printing of Logged Data:
All logged information can be sent to a computer or serial printer using an RS232 serial protocol. The amount of data printed is determined by the PRINT RATE key on the *QUESTemp° II.*

Note that if the unit is in the RUN mode when printing is initiated, the RUN mode will be canceled and data logging will cease.

Printer Cables:
Connect the meter directly to a serial printer using cable #58-847. [A serial printer's input is typically a 25 pin female (holes) connector. Do not use cable #58-847 in conjunction with a computer's printer cable because that connects into the printer's parallel input port. Many printers are parallel only and

can not accept data from the *QUESTemp° II*. For printers that have both serial and parallel inputs, refer to the printer's manual for configuring the serial port.)

Computer Cables:
Connect the meter to a computer using cable #58-867 for a 25 pin serial port. (The standard for a computer's serial port is a 25 pin or a 9 pin male (pins) connector. Do not connect to the computer's printer output port which is a 25 pin female (holes) connector. If you have cable #58-867 but your computer's serial port has only 9 pins, then you may use a 25 to 9 pin converter available at most computer or electronic stores. No other cables should be used.)

Computer Downloading using Windows™:
There is a variety of commercially available software that can easily accept data from the QUESTemp° II. These software packages are usually termed "communications software". Microsoft Windows ™ has a communications program under the ACCESSORIES icon called TERMINAL. Instructions on how to use TERMINAL are located in the Windows ™ manuals.

Using any of these communications programs, the user must select the com (serial) port and the baud rate. The Quest cable must be plugged into the selected com port and the baud rate on the unit must match the rate selected in the software. The PC programs also need the following information in their setup:

data bits = 8 stop bits = 2 parity = none handshaking (flow control) = hardware

For TERMINAL, the settings are found by first selecting SETTINGS, then COMMUNICATIONS.

- To initiate printing, use the following sequence: with the unit ON, plug the printer cable into the OUTPUT port of the QUESTemp° II. Be sure the desired PRINT RATE is selected (see the key function PRINT RATE).
- Press the PRINT/DATA key. If the default baud rate (speed of data transmission) in the display is not the desired baud rate, press the PRINT/DATA key a second time and use the ARROW key to select a new rate. [If you are downloading to a computer, be sure that it is ready to accept data prior to moving to step 6.5.3)
- Press ENTER and the data will be sent. "Prn" will appear in the display until all of the data has been sent.
- To halt printing, simply press the PRINT/DATA key while "Prn" is still in the display.

Attachment 9.4
Example of a Print-out from the *QUESTemp° II* meter.

QUEST ELECTRONICS
QUESTEMP II Personal Temperature Monitor

Serial Number: JU1030001 Software Version Number: 1.1

Name: Date:

Location:

SAMPLE

[1]Start Time: 11:34 [2]End Time: 13:32 [3]Total Run Time: 01:58

[4]Alarm Level Setting: 38.0 oC
[5]Print Rate: 1 Min.

[6]High Temperature: 38.1 oC At Time: 13:32
[7]Low Temperature: 36.1 oC At Time: 11:34

[8]CAL in degree C	@ Time
0.4	11:41:20

SAMPLED DATA

Time Hr:Min	[9]Ear Temp. oC	oF	[10]Mold Temp. oC	oF	[11]Oral Temp. oC	oF	[12]Alarm
11:34	36.1	97.0	32.7	90.9			
11:35	36.1	97.0	32.7	90.9			
11:36	36.2	97.2	32.8	91.1			
11:37	36.3	97.4	32.9	91.3			
11:38	36.3	97.4	33.0	91.5			
11:39	36.4	97.5	33.1	91.7	36.7	98.1	
11:40	36.4	97.5	33.1	91.7	36.9	98.5	
11:41	36.4	97.5	32.9	91.3	36.9	98.5	
11:42	36.9	98.4	33.0	91.5			
11:43	36.9	98.4	33.0	91.5			
13:29	37.9	100.2	27.6	81.7			
13:30	37.9	100.2	27.4	81.3			
13:31	38.0	100.4	27.3	81.1			*
13:32	38.1	100.6	27.2	80.9			**

Heat Stress Measurements

QUESTemp 34 and QUESTemp II Monitors

Job Performance Measure (JPM) Completion Certificate

Candidate's Name	Life Number:

	Element of Qualification	Unsatis-factory	Recov-ered	Satisf-.actory
	Principles of Heat Stress			
1	Has knowledge of heat stress temperature measurement and the reason for sampling.			
2	Understands the varying methods of heat stress monitoring and when each is appropriate.			
	Set up of meter			
1	Can demonstrate how to assemble and activate the meter. ☐ *QUESTemp 34* ☐ *QUESTemp II* Dosimeter ☐ Other:			
2	*QUESTemp* 34: Can demonstrate how to place the meter outdoors and add water to thermometer.			
3	Site Notification- Can demonstrate how to Log onto computer w/ password; Log onto BNL network w/ password; Log on to Oracle w/ password; Run the Heat Stress evaluation program.			
4	*QUESTemp II* Dosimeter: Can demonstrate how to calibrate (adjust for body core temperature), set alarm levels and operate the meter.			
5	Can demonstrate how to respond appropriately to alarms and recommend corrective actions.			
	Documentation of Monitoring			
1	Demonstrates how to Download data and Print a hardcopy of monitoring data.			
2	Knows the list of organizations and individuals to receive data reports and timeliness requirements.			

Employee: I accept the responsibility for performing this task as demonstrated within this JPM and the corresponding SOP.

Candidate Signature:	Date:

Evaluator: I certify the candidate has satisfactorily performed each of the above listed steps and is capable of performing the task unsupervised.

Evaluator Signature:	Date: